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*FORTY-SEVENTH*

**PROGRESS REPORT**

**OF**

# THE FIRESTONE TIRE & RUBBER COMPANY

**ON**

# BATTALION ANTI-TANK PROJECT

**UNDER**

**Contract No. DA-33-019-ORD-1202**
**ORDNANCE DEPARTMENT PROJECTS**
**TS4-4020—WEAPONS AND ACCESSORIES**
**TM1-1540—AMMUNITION**

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**THE FIRESTONE TIRE & RUBBER COMPANY**
**Defense Research Division**
**Akron, Ohio**

**JUNE 1954**

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Akron, Ohio
September 14, 1954

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Dayton, Ohio

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Attached are corrected pages 10, 11 and 12 for the Forty-Seventh Progress Report for June 1954 on Contract DA-33-019-ORD-1202. The pages are being replaced due to transposition of the Table headings as they appeared in the original.

Please replace the original pages 10, 11 and 12 with the corrected ones attached and return the original three pages to this office, together with one copy of the signed transmittal form also attached.

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Defense Research Division

SBS:mjm

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FORTY-SEVENTH

PROGRESS REPORT

OF

THE FIRESTONE TIRE & RUBBER CO.

ON

# BATTALION ANTI-TANK PROJECT

Contract No.
DA-33-019-ORD-1202

RAD Nos. ORDTS 3-3955
ORDTS 3-3957
ORDTA 3-3952

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THE FIRESTONE TIRE & RUBBER CO.
Defense Research Division
Akron, Ohio

JUNE, 1954

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# INDEX

## ABSTRACT

90MM BAT Projectile - Two folding fin designs being produced for test purposes are illustrated. Accuracy tests have been suspended until the completion of a new vent ring for the test rifle. Erosion of the original vent ring had caused undesirable forward recoil.

A 90mm fixed fin BAT projectile, based on the 105mm T171 configuration, is being designed. To establish preliminary data concerning a fixed fin round when fired from the 90mm BAT rifle, a group of 90mm fixed fin rounds (T300E50) available from another contract, DAI-33-019-501-ORD (P)-16 were fired from the 90mm BAT rifle at a 1000-yard target. Two rounds were expended in getting on the target. The remaining seven rounds hit the target with probable errors of dispersion of ±.31 mil vertically ±.26 mil horizontally. The roll rate data and spin rate data are presented.

T119 (M344) Projectile - Two studies were conducted with this projectile during this report period (1) the evaluation of the production tapered stop, and (2) determination of the effect of reduced bourrelet diameter upon the accuracy of the projectile. The data are being reduced and details of the tests will be given in the next progress report.

T120 Projectile - Investigations with internally and externally fluted cones have continued. Fifty basic 45-degree smooth walled cones were machined from copper bar, twenty-five were coined with DRD78-2 HW1 flute profile (5-degree index angle) and twenty-five were coined with DRD78-2 HW2 flute profile (20 degree index angle). All cones were assembled in DRC15 test assemblies and fired against mild steel target plate at 7.5 inches standoff. The inspection and penetration data are presented and compared with similar data for a control group. The effects of wall thickness upon penetration and upon optimum frequency are discussed.

Fuzes - Tests to investigate the sensitivity of "potted lucky" nose elements have continued. Tests were conducted which indicated that the lucky element is functioned by a shock wave transmitted through the metal cap. A future program outlines a series of tests to study the sensitivity of the system.

# 90 MM. BAT PROJECTILE

## Folding Fin Type

The E2 and E4 designs of the 90mm BAT Projectile, shown in Fig. 1, are being produced for test purposes. Projectiles of both types are available for accuracy programs but the firing tests have been delayed until the completion of a new vent ring for the rifle to replace the original ring. Erosion of the original vent ring has increased the vent area and causes the gun to have an undesirable forward recoil. An M10 powder will be used for future tests of the 90mm BAT Weapon at Erie Ordnance Depot as the supply of M5 powder is exhausted.

Voids were found to be present in the inert plaster filler of a number of 90mm BAT E2 projectiles. A test is being conducted to determine the cause of the voids. In addition, a program is planned for determining the effect of dynamic unbalance, caused by plaster voids, upon projectile flight and accuracy.

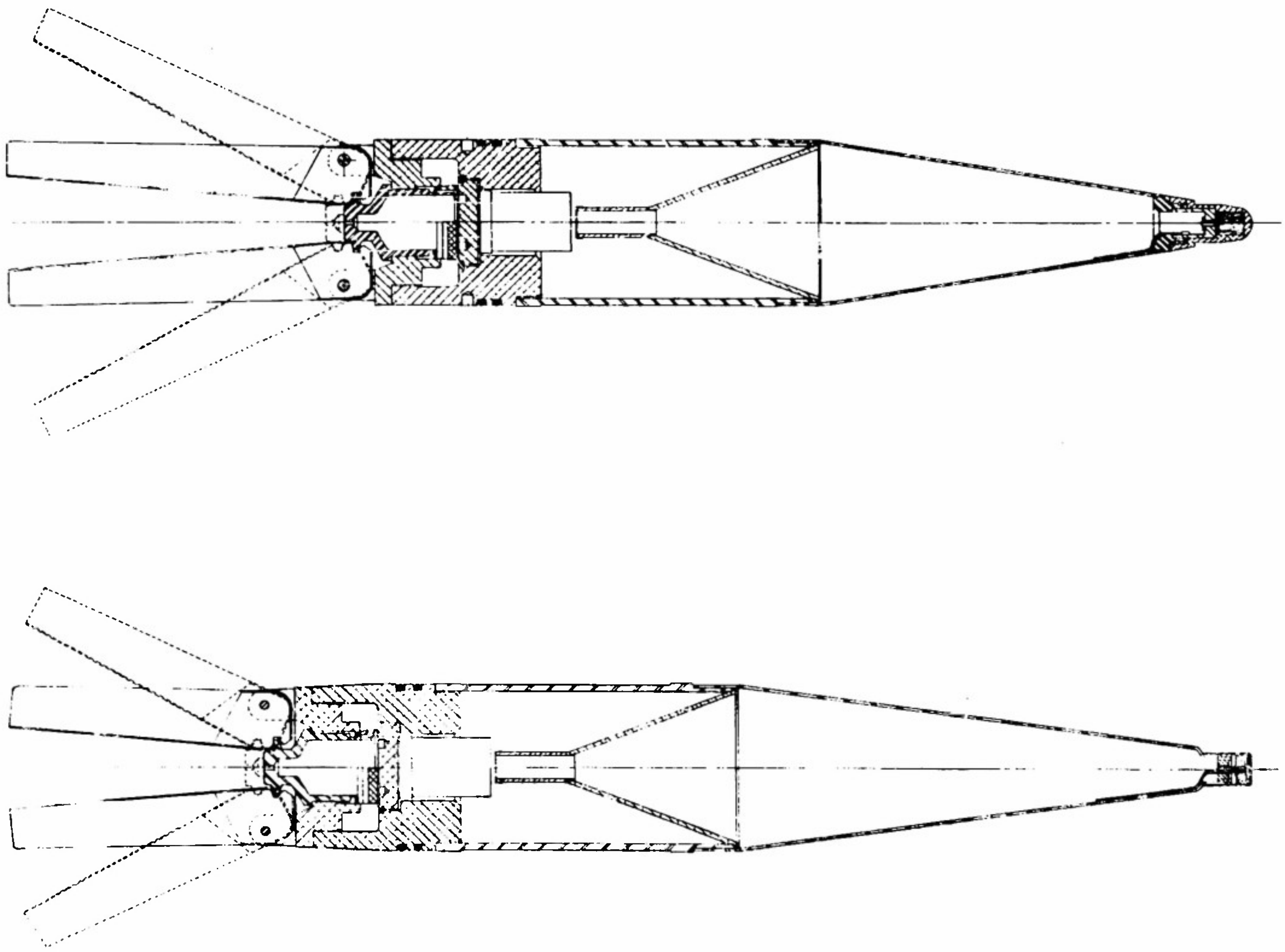


Fig. 1. 90 mm. BAT Projectile Types E2 and E4.

## Fixed Fin Type

A 90mm fixed fin BAT projectile, based on the 105mm T171 configuration, is being designed. In order to test a fixed fin round in the 90mm BAT rifle before the above design is completed, existing T300E50 projectiles were fired from the 90mm BAT rifle. The external configuration of the T300E50 is similar to the T171E11 Projectile (See Fig. 2).

Nine of these rounds (Fig. 2), equipped with nylon obturators and pop-out pins, were fired for accuracy and spin determination. These projectiles were launched from the 90mm BAT rifle, with a 1/25 twist tube, through a series of 3 yaw cards, at an 18 ft x 18 ft target placed approximately 1000 yards from the muzzle. A reference mark was placed on the yaw cards, so that the roll angle at each position could be measured. The firing data for this program are in Table I.

Two rounds were expended in getting on the target. The remaining 7 rounds hit the target, yielding probable errors of ±.31 mil vertically and ±.26 mil horizontally. This group, fired with an average muzzle velocity of 2000 fps, at 15.2 mils elevation and zero azimuth, had a center of impact 1.15 mils below and 1.24 mils to the right of the target center. The target plot for this program is shown in Fig. 3.

The roll angle-range relationships, Fig. 4, indicate that a linear fit of this data is reasonable. The roll rates and spins in rps for these rounds are shown in Table II. The average of the nine spins measured, 59 rps, is approximately four times that needed to dynamically stabilize this round.

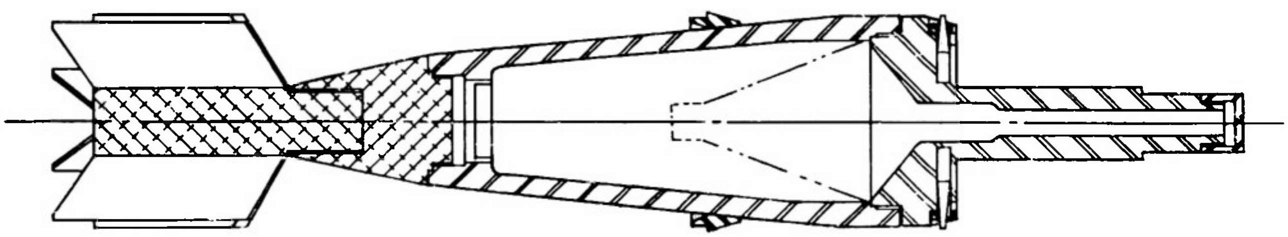


Fig. 2. T300E50 Projectile.
With Nylon Obturator No. 2, and Pop-out Pins.

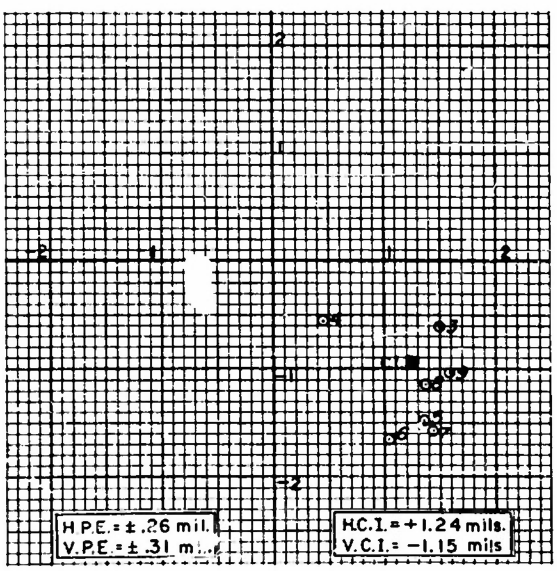



Fig. 3. Dispersion Chart
90 mm. BAT Fixed Fin Projectile.

# Table I
## Range Data
### *Performance Of Fixed Fin Round*
### 90 mm. BAT Rifle; T300E50 Projectile

Sheet 1 of 1

## RANGE DATA

Date of Test 28 June 1954
Location E.O.D.

Purpose of Test Performance of Fixed Fin from 90mm Rifle.
Program No. 158

**PROJECTILE**

Model T 300
Type E 50
Weight Nom 13.416
C.G. Location
Bourrelet Dia. 3.541 $^{-.002}$
Retard. Factor
Special Features Fixed Fin

**TEST GUN**

Model BAT 90MM
Type Recoilless
Serial No. 1
Chamber B-4982-2
Bushing(Vent) 22-C-226-P
Tube D-453-10 (1/25)
Sighting Equip. Bare Sight, Gunners Quad. and M17 Elbow Scope.
Mount:
Type Rigid Ser. No.
Constant
Firing Mech. Solenoid

**MISCELLANEOUS DATA**

Range 998 yard target
Propellant:
Type M-5 Web .040 Weight 6 lb. 13 oz.
Lot No. RAD 16415
Primer M57 (13°)
Shell Case MOD T53E1
Liner T-4
Temperatures:
Magazine
Max. Min. Present 69°
Loading Room 70° Ambient

| Round Number | | Proj. Number | Proj. Weight (lb.) | Propell. Weight (lb.-oz.) | Chamber Pressure (psi) (Cu) (Internal M3) | Muzzle Velocity (fps) Instr. | Muzzle Velocity (fps) Actual | Azim. (mils) | Elevation (mils) zero/su. | Position of Hit (inches) Vert. | Position of Hit (inches) Horiz. | Corrected Posit. of Hit (mils) Vert. | Corrected Posit. of Hit (mils) Horiz. | Retard f/s/f | Wind Vel. & Dir. | | Observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7510 | 1 | 40 | 13.35 | 6-13 | 13,000 / 13,100 | 1995 | 2009 | 0 | 58 + 10 | - | - | - | - | - | 00-325° | 1 | Hit short of target. |
| | 2 | | | | | | | | | | | | | | | 2 | |
| 7511 | 3 | 43 | 13.35 | 6-13 | 13,200 / 13,700 | 1995 | 2009 | 0 | 58 + 13 | - | - | - | - | - | 04-035° | 3 | Not on target |
| | 4 | | | | | | | | | | | | | | | 4 | |
| 7512 | 5 | 41 | 13.35 | 6-13 | 13,300 / 12,800 | 1188 | 2002 | 0 | 58 + 13 | -101 | +54 | -.61* | +1.50 | .158 | 025-020° | 5* | Corrected to 15.2 Mil Super. |
| | 6 | | | | | | | | | | | | | | | 6 | |
| 7513 | 7 | 39 | 13.35 | 6-13 | 13,100 / — | 1976 | 1990 | 0 | 58 + 152 | -20 | +16½ | -.56 | +.46 | .118 | 05-035° | 7 | |
| | 8 | | | | | | | | | | | | | | | 8 | |
| 7514 | 9 | 36 | 13.40 | 6-13 | 13,100 / 10,900 | 1985 | 1999 | 0 | 58 + 152 | -53½ | +48 | -1.49 | +1.34 | .155 | 04-025° | 9 | |
| | 10 | | | | | | | | | | | | | | | 10 | |
| 7515 | 11 | 38 | 13.37 | 6-13 | 12,100 / 12,600 | 1955 | 1969 | 0 | 58 + 152 | -60 | +37 | -1.67 | +1.03 | .233 | 08-015° | 11 | |
| | 12 | | | | | | | | | | | | | | | 12 | |
| 7516 | 13 | 37 | 13.35 | 6-13 | 13,900 / 9,300 | 2003 | 2017 | 0 | 58 + 152 | -57" | +51 | -1.59 | +1.42 | .207 | 03-005° | 13 | |
| | 14 | | | | | | | | | | | | | | | 14 | |
| 7517 | 15 | 35 | 13.37 | 6-13 | 14,200 / 13,200 | 2004 | 2018 | 0 | 58 + 152 | -40½ | +49½ | -1.13 | +1.38 | - | 04-010° | 15 | |
| | 16 | | | | | | | | | | | | | | | 16 | |
| 7518 | 17 | 42 | 13.35 | 6-13 | 12,900 / 12,800 | 1991 | 2004 | 0 | 58 + 152 | -37 | +57 | -1.03 | +1.59 | .152 | 04-000° | 17 | |
| | 18 | Average | 13.36 | | Average | 1988 | 2003 | | | | | Average | | .171 | | 18 | |
| | 19 | | | | | | | | | | | | | | | 19 | |
| | 20 | | | | | | | | | | | | | | | 20 | |
| | 21 | | | | | | | | | | | | | | | 21 | |
| | 22 | | | | | | | | | | | | | | | 22 | |

Muzzle — 55.48 — 1 — 47.81 — 2 — 110.41 — 39.59
Screen (Coil) Distances

Muzzle — 47.73 — 1 — 7.75 — 2 — 47.81 — 3 — 4 — 5 — 6
Distances (Yaw Cards) (Spin Screen)

Center of Impact V=-1.15 mil H=1.25 mil
Probable Error:
Vertical (mils) ± .31
Horizontal (mils) ± .26

Proof Director E. Hoffman Signed
Observers W.D. Davies

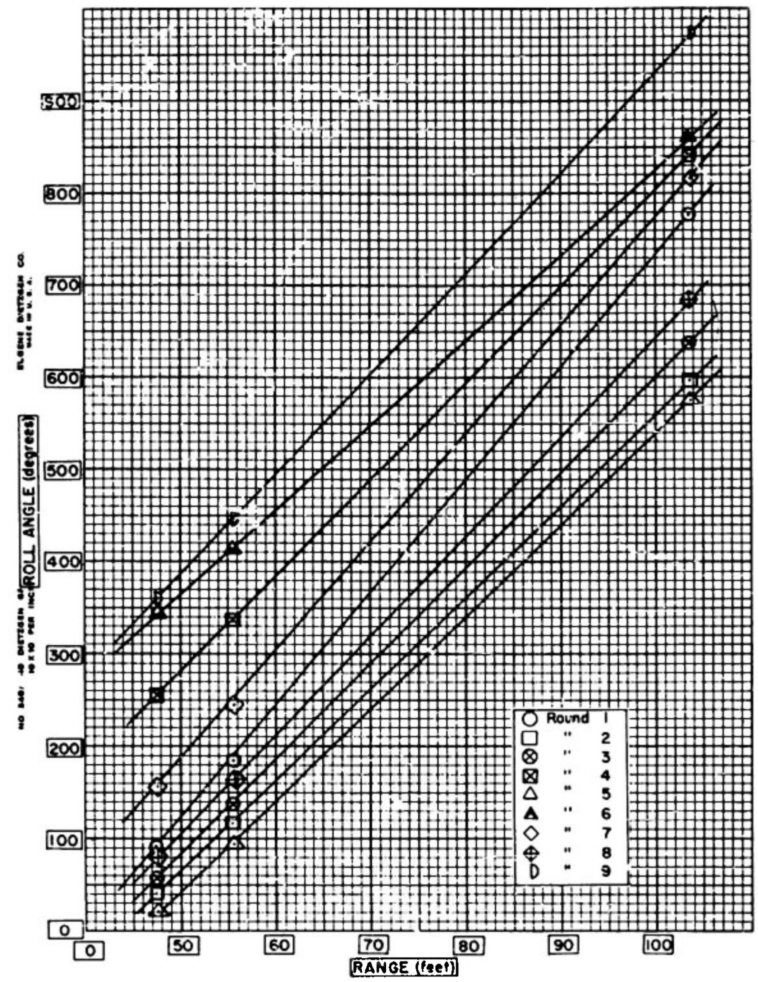



Fig. 4. Roll Angle Versus Range.
90 mm. BAT Fixed Fin Projectile.

**Table II**
**Roll Data**
***T300E50 Projectile***
**Fired From 90 mm. BAT Rifle**

| Round No. | $\phi'$ (deg./ft.) | Spin (rps) |
|---|---|---|
| 1 | 12.4 | 69 |
| 2 | 10.0 | 56 |
| 3 | 10.4 | 58 |
| 4 | 10.5 | 58 |
| 5 | 10.0 | 56 |
| 6 | 8.7 | 48 |
| 7 | 11.9 | 67 |
| 8 | 10.9 | 61 |
| 9 | 11.0 | 61 |

## Future Program

1. Design 90mm BAT round based on T171E12 projectile.

2. Develop obturating band to provide approximately 15 rps at r[illegible]le.

3. Test the projectile in (1), using the obturating band in (2), for accuracy at 1000 yards.

## T119 PROJECTILE

During the month of June two T119E11 programs were completed. The first program fired was to evaluate the production tapered stop under extremes of pressure and temperature. The second was a program to determine the effect of reduced bourrelet diameter on accuracy of the T119E11 projectile. Due to the large number of rounds involved in each program the range data evaluation has not been completed; therefore details of these firings will appear in the next monthly report.

## Serrated Liners

Investigations with internally and externally fluted liners of the DRD78-2 type (Fig. 2, page 3, Supplement to the Thirteenth Progress Report) have continued. The effect of relative indexing between inside and outside flutes was reported in the Supplements to the Thirteenth, Twenty-Ninth, and Thirty-Fourth Progress Reports.

The optimum frequency ($\gamma_o$) of this cone has been found to vary in an approximately sinusoidal fashion as the index angle ($\theta$) increases from $0^o$ to its maximum of $22.5^o$ (determined by $360^o/n$, where n = the number of flutes per cone). The phenomenon would, of course, be cyclic in nature, the limits of $\theta$ ($0^o$ to $22.5^o$) representing a complete cycle, and the number of flutes per cone determining the number of cycles. This performance through one cycle is illustrated in Fig. 6, page 14, Supplement to the Thirty-Fourth Progress Report. Fig. 7, page 14 of the same report shows the penetration efficiency as a function of $\theta$. It was noted that when a peak optimum frequency was reached in the region of the low index angles the penetration was satisfactory but that in the region where large index angles were employed, the maximum average penetration was too low to be of practical value. Because the low penetration was believed to result from the minimum wall thickness being too thin, two new series of DRD78-2 cones were manufactured having index angles of $5^o$ and $20^o$ and an increased minimum wall thickness.

For the present experiment, fifty basic $45^o$, smooth walled cones were machined from soft, drawn electrolytic copper bar, QQ-C-502. Twenty-five of these were then coined with the DRD78-2 HW1 flute profile and the remaining twenty-five were coined with the DRD78-2 HW2 flute profile, as shown in Fig. 5. It was specified that the minimum wall thickness would be .100 in.

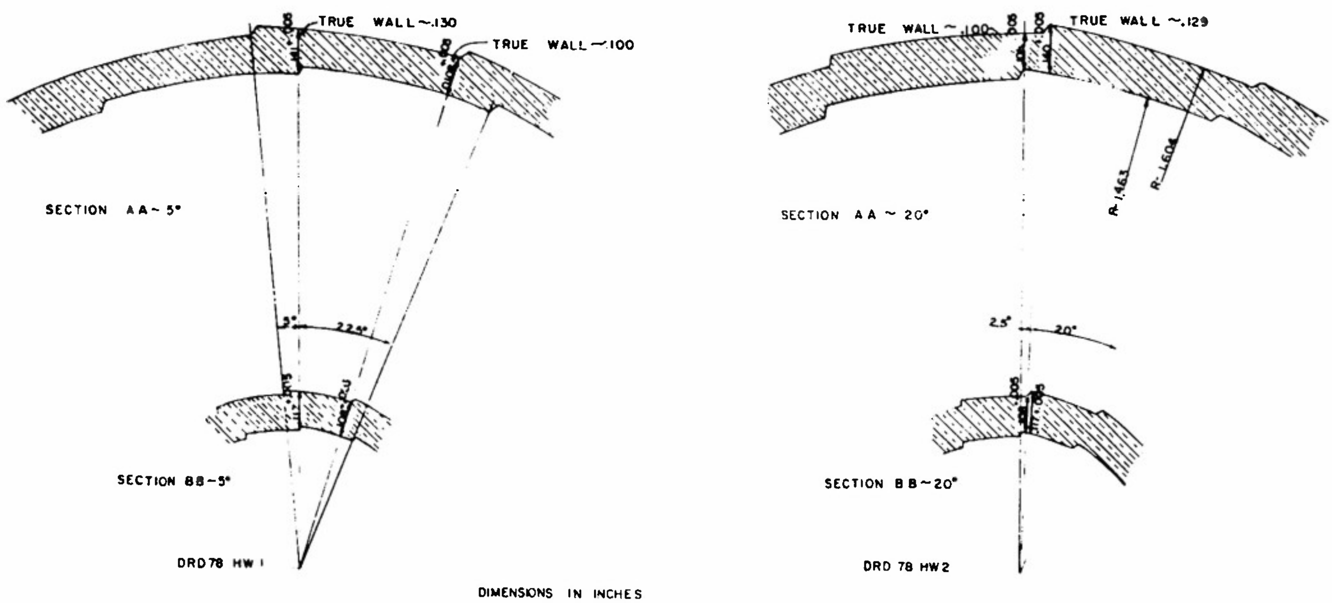



Fig. 5. Flute Profiles.
DRD78-2 HW1 and DRD78-2 HW2

The sixteen matching internal and external flutes were to have a nominal depth of .0294 in at a datum .484 in above the base and were to decrease linearly with height above the base so as to "run out" at the theoretical apex of the cone. The minimum wall thickness is measured from the root of the internal flute to the opposite external surface.

All cones were assembled in DRC15 test assemblies (Fig. 5, Twenty-Fourth Progress Report) and tested against mild steel target plate at a standoff of 7.5 in. The DRB2 smooth cones used as controls were machined from hard drawn electrolytic copper bar, QQ-C-502.

The inspection and penetration data for the two series of fluted liners and for the smooth controls are shown in Tables III through VIII. The spin rate versus penetration curves are shown in Figs. 6 and 7. Table IX is a summary of the results.

# Table III
## Inspection Data
***DRD78 HW1 Cones; 5-Degree Index Angle***

| Cone Number | Average Flute Depth (inches) | | | | Average Minimum Wall Thickness (in.) | | Max. Wall Thickness Variation (in.) | | Max. Wall Waviness (in.) | | Datum Dia (in.) (Over Crests) | | Concentricity T.I.R.[1,2] (in.) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Interior | | Exterior | | | | | | | | | | | | |
| | Base Dat. | Apex Dat. | Base Dat. | Apex Dat. | Base Dat. | Apex Dat. | Transverse | Longitud. | O. D. | I. D. | Base | Apex | Base Datum | Apex Datum | Cone Tip Tube in Assembly |
| DRD78HW1 | .0294 | .0088 | .0294 | .0088 | $.100^{+.005}$ | $.100^{+.005}$ | .002 | .006 | ---- | ---- | 3.066 | 1.072 | .003 | .003 | .015 (Nominal) |
| C16 - 271 | .0283 | .0091 | .0281 | .0088 | .103 | .117 | .002 | .004 | < .001 | < .001 | 3.070 | 1.090 | .002 | .003 | .005 |
| 272 | .0275 | .0077 | .0280 | .0092 | .102 | .117 | .001 | .014 | < .001 | < .001 | 3.070 | 1.084 | .003 | .003 | .011 |
| 273 | .0280 | .0076 | .0280 | .0089 | .103 | .118 | .001 | .016 | < .001 | < .001 | 3.070 | 1.084 | .002 | .003 | .005 |
| 274 | .0273 | .0076 | .0283 | .0090 | .103 | .117 | .001 | .016 | < .001 | < .001 | 3.070 | 1.084 | .002 | .002 | .006 |
| 275 | .0273 | .0076 | .0279 | .0096 | .102 | .118 | .001 | .017 | < .001 | < .001 | 3.070 | 1.084 | .003 | .002 | .004 |
| 276 | .0271 | .0077 | .0277 | .0092 | .103 | .119 | .002 | .016 | < .001 | < .001 | 3.070 | 1.084 | .003 | .003 | .009 |
| 277 | .0257 | .0074 | .0274 | .0085 | .102 | .118 | .001 | .016 | < .001 | < .001 | 3.070 | 1.084 | .002 | .002 | .006 |
| 278 | .0258 | .0083 | .0280 | .0089 | .107 | .119 | .003 | .014 | < .001 | < .001 | 3.070 | 1.084 | .003 | .003 | .002 |
| 279 | .0278 | .0065 | .0277 | .0092 | .102 | .117 | .002 | .016 | < .001 | < .001 | 3.070 | 1.086 | .092 | .002 | .002 |
| 280 | .0276 | .0072 | .0277 | .0090 | .102 | .118 | .001 | .017 | < .001 | < .001 | 3.070 | 1.086 | .002 | .001 | .007 |
| 281 | .0290 | .0064 | .0276 | .0087 | .108 | .119 | .002 | .013 | < .001 | < .001 | 3.070 | 1.086 | .003 | .002 | .006 |
| 282 | .0266 | .0061 | .0276 | .0090 | .102 | .117 | .001 | .016 | < .001 | < .001 | 3.070 | 1.084 | .002 | .001 | .005 |
| 283 | .0261 | .0075 | .0276 | .0087 | .106 | .118 | .003 | .015 | < .001 | < .001 | 3.070 | 1.084 | .002 | .004 | .004 |
| 284 | .0276 | .0062 | .0272 | .0088 | .107 | .118 | .002 | .013 | < .001 | < .001 | 3.070 | 1.084 | .004 | .004 | .011 |
| 285 | .0278 | .0064 | .0273 | .0085 | .102 | .118 | .001 | .018 | < .001 | < .001 | 3.070 | 1.084 | .003 | .005 | .005 |
| 286 | .0273 | .0071 | .0274 | .0089 | .102 | .117 | .002 | .017 | < .001 | < .001 | 3.070 | 1.084 | .002 | .003 | .003 |
| 287 | .0275 | .0070 | .0275 | .0088 | .103 | .119 | .001 | .017 | < .001 | < .001 | 3.070 | 1.084 | .002 | .001 | .012 |
| 288 | .0274 | .0061 | .0276 | .0090 | .103 | .118 | .002 | .017 | < .001 | < .001 | 3.070 | 1.084 | .004 | .004 | .011 |
| 289 | .0266 | .0061 | .0276 | .0086 | .107 | .120 | .004 | .016 | < .001 | < .001 | 3.070 | 1.086 | .002 | .002 | .005 |
| 290 | .0273 | .0069 | .0279 | .0086 | .108 | .121 | .002 | .014 | < .001 | < .001 | 3.070 | 1.084 | .004 | .003 | .014 |
| 291 | .0272 | .0069 | .0275 | .0087 | .102 | .118 | .001 | .016 | < .001 | < .001 | 3.070 | 1.084 | .002 | .002 | .006 |
| 292 | .0270 | .0071 | .0273 | .0090 | .102 | .118 | .001 | .016 | < .001 | < .001 | 3.070 | 1.084 | .001 | .002 | .011 |
| 294 | .0255 | .0059 | .0278 | .0085 | .105 | .118 | .002 | .015 | < .001 | < .001 | 3.070 | 1.084 | .003 | .003 | .007 |
| 295 | .0270 | .0067 | .0269 | .0086 | .107 | .121 | .002 | .016 | < .001 | < .001 | 3.070 | 1.084 | .004 | .004 | .005 |
| 296 | .0269 | .0065 | .0272 | .0088 | .102 | .118 | .001 | .017 | < .001 | < .001 | 3.070 | 1.086 | .002 | .001 | .011 |
| Avg. | .0272 | .0070 | .0276 | .0087 | .1050 | .1188 | .0017 | .0153 | < .001 | < .001 | 3.070 | 1.085 | .0025 | .0026 | .0069 |
| Std. Dev. | ±.0008 | ±.0077 | ±.0005 | ±.0002 | ±.0061 | ±.0027 | ±.0007 | ±.0026 | ---- | ---- | ----- | ±.001 | ±.0007 | ±.0010 | ±.0033 |

Notes:
1. Lower datum is .484 inch above base; upper datum 2.875 inches above base.
2. The indicated measurement at each datum is the total indicator runout of the liner's outside surface relative to the register diameter.

# Table IV
## Inspection Data
***DRD78 HW2 Cones; 20-Degree Index Angle***

| Cone Number | Average Flute Depth (inch) | | | | Avg. Minimum Wall Thickness (in.) | | Max. Wall Thickness Variation (in.) | | Max. Wall Waviness (in.) | | Datum Dia. (in.) (Over Crests) | | Concentricity - T.I.R.[1,2] (in.) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Interior | | Exterior | | | | | | | | | | Base Datum | Apex Datum | Cone Tip Tube in Assembly |
| | Base Dat. | Apex Dat. | Base Dat. | Apex Dat. | Base Dat. | Apex Dat. | Transverse | Longitud. | O. D. | I. D. | Base | Apex | | | |
| DRD78 HW2 | .0294 | .0088 | .0294 | .0088 | $.100^{+.00[illegible]}$ | $.100^{+.005}$ | .002 | .006 | ---- | ---- | 3.066 | 1.072 | .003 | .003 | .015 (Nominal) |
| C16 - 297 | .0267 | .0067 | .0279 | .0086 | .105 | .133 | .003 | .030 | < .001 | < .001 | 3.070 | 1.084 | .004 | .004 | .006 |
| 298 | .0275 | .0079 | .0256 | .0074 | .105 | .132 | .006 | .032 | < .001 | < .001 | 3.070 | 1.086 | .002 | .002 | .014 |
| 299 | .0276 | .0077 | .0265 | .0072 | .104 | .132 | .002 | .030 | < .001 | < .001 | 3.070 | 1.086 | .002 | .001 | .008 |
| 300 | .0269 | .0077 | .0280 | .0081 | .104 | .130 | .001 | .027 | < .001 | < .001 | 3.070 | 1.086 | .002 | .002 | .006 |
| 301 | .0269 | .0072 | .0272 | .0085 | .104 | .132 | .004 | .031 | < .001 | < .001 | 3.070 | 1.086 | .002 | .003 | .015 |
| 302 | .0267 | .0065 | .0271 | .0085 | .104 | .133 | .002 | .030 | < .001 | < .001 | 3.070 | 1.087 | .003 | .003 | .005 |
| 303 | .0275 | .0068 | .0269 | .0087 | .104 | .132 | .003 | .030 | < .001 | < .001 | 3.070 | 1.087 | .003 | .003 | .005 |
| 304 | .0271 | .0066 | .0278 | .0086 | .105 | .133 | .002 | .030 | < .001 | < .001 | 3.070 | 1.086 | .002 | .002 | .015 |
| 305 | .0274 | .0064 | .0280 | .0088 | .103 | .131 | .002 | .029 | < .001 | < .001 | 3.070 | 1.085 | .002 | .002 | .011 |
| 307 | .0264 | .0064 | .0277 | .0091 | .104 | .132 | .001 | .029 | < .001 | < .001 | 3.070 | 1.086 | .002 | .002 | .009 |
| 308 | .0266 | .0069 | .0275 | .0089 | .105 | .141 | .002 | .037 | < .001 | < .001 | 3.070 | 1.086 | .004 | .004 | .010 |
| 309 | .0267 | .0072 | .0279 | .0089 | .104 | .132 | .003 | .031 | < .001 | < .001 | 3.070 | 1.085 | .002 | .003 | .006 |
| 310 | .0263 | .0072 | .0277 | .0088 | .105 | .133 | .003 | .030 | < .001 | < .001 | 3.070 | 1.084 | .004 | .004 | .012 |
| 311 | .0267 | .0071 | .0278 | .0088 | .104 | .131 | .003 | .030 | < .001 | < .001 | 3.070 | 1.084 | .004 | .002 | .012 |
| 312 | .0266 | .0072 | .0277 | .0090 | .104 | .132 | .001 | .028 | < .001 | < .001 | 3.070 | 1.084 | .003 | .002 | .014 |
| 313 | .0266 | .0070 | .0278 | .0086 | .105 | .133 | .002 | .030 | < .001 | < .001 | 3.070 | 1.084 | .004 | .002 | .009 |
| 314 | .0267 | .0070 | .0276 | .0090 | .104 | .133 | .002 | .030 | < .001 | < .001 | 3.070 | 1.084 | .002 | .004 | .012 |
| 315 | .0267 | .0069 | .0277 | .0089 | .104 | .132 | .002 | .030 | < .001 | < .001 | 3.070 | 1.084 | .003 | .002 | .005 |
| 316 | .0266 | .0071 | .0277 | .0089 | .104 | .132 | .003 | .030 | < .001 | < .001 | 3.070 | 1.086 | .003 | .003 | .003 |
| 317 | .0265 | .0071 | .0276 | .0089 | .104 | .133 | .003 | .031 | < .001 | < .001 | 3.070 | 1.084 | .003 | .003 | .010 |
| 318 | .0268 | .0068 | .0277 | .0088 | .104 | .132 | .004 | .031 | < .001 | < .001 | 3.070 | 1.084 | .003 | .003 | .011 |
| 319 | .0266 | .0069 | .0278 | .0089 | .105 | .132 | .004 | .031 | < .001 | < .001 | 3.070 | 1.084 | .003 | .002 | .002 |
| 320 | .0266 | .0066 | .0274 | .0088 | .104 | .133 | .002 | .030 | < .001 | < .001 | 3.070 | 1.084 | .002 | .002 | .004 |
| 321 | .0270 | .0065 | .0277 | .0088 | .104 | .133 | .002 | .030 | < .001 | < .001 | 3.070 | 1.084 | .004 | .005 | .008 |
| 322 | .0268 | .0064 | .0278 | .0085 | .104 | .131 | .002 | .029 | < .001 | < .001 | 3.070 | 1.084 | .006 | .002 | .011 |
| Avg. | .0268 | .0069 | .0275 | .0086 | .1042 | .1325 | .0025 | .0302 | < .001 | < .001 | 3.070 | 1.085 | .0029 | .0027 | .0089 |
| Std. Dev. | ±.0003 | ±.0004 | ±.0005 | ±.0014 | ±.0005 | ±.0014 | ±.0011 | ±.0017 | ---- | ---- | ---- | ± .001 | ±.0010 | ±.0010 | ±.0037 |

Notes:
1. Lower datum is .484 inch above base; upper datum 2.875 inches above base.
2. The indicated measurement at each datum is the total indicator runout of the liner's outside surface relative to the register diameter.

Notes:
1. Lower datum is .484 inch above base; upper datum 2.875 inches above base.
2. The indicated measurement at each datum is the total indicator runout of the liner's outside surface relative to the register diameter.

## Table V
## Inspection Data
### *DRB2-9 Controls For Modified DRB78-2 Cones*

| Cone Number | Wall Thickness inch | | | Max. Wall Thickness inch | | Max. Wall Waviness inch | | Concentricity – T.I.R. (in.)[1,2] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Max. | Min. | Avg. | Transverse | Longitud. | O. D. | I. D. | Base Datum | Apex Datum | Cone Tip Tube in Assembly |
| Specification | | | | | | | | | | (Nominal) |
| DRB 2-9 | .100 | .095 | .0975 | .001 | .003 | .003 | .003 | .003 | .003 | .015 |
| A1191 | .100 | .100 | .1000 | < .001 | < .001 | < .001 | < .001 | .002 | .008 | .005 |
| A1192 | .098 | .097 | .0974 | .001 | .001 | < .001 | < .001 | .002 | .001 | .012 |
| A1193 | .100 | .100 | .1000 | < .001 | < .001 | < .001 | < .001 | .003 | .003 | .014 |
| A1194 | .102 | .100 | .1010 | .001 | .002 | < .001 | < .001 | .003 | .002 | .014 |
| A1195 | .101 | .100 | .1000 | .001 | .001 | < .001 | < .001 | .002 | .004 | .008 |
| Average | .1002 | .0994 | .0997 | < .001 | < .001 | < .001 | < .001 | .0024 | .0036 | .0106 |
| Std. Dev. | ±.0015 | ±.0045 | ±.0014 | ---- | ---- | ---- | ---- | ±.0007 | ±.0027 | ±.0040 |

Notes:
1. Base datum is .484 inch above base; apex datum is 2.875 inches above base.
2. The indicated measurement at each datum is the total indicator runout of the liner's outside surface relative to the register diameter. The difference between the runout at the two datum planes is an indication of the lack of perpendicularity of the register plane and the liner's axis.

## Table VI
## Penetration Data
### *DRD78 HW1 Cones; 5-Degree Index Angle*

| Serial Number | Comp. B Wt. Lbs. | Standoff Inches | Rotation R.P.S. | Penetration Inches Mild Steel | | Maximum Spread | Standard Deviation |
|---|---|---|---|---|---|---|---|
| C16 - 271 | 2.50 | 7.5 | 0 | | 6.19 | | |
| C16 - 272 | 2.50 | 7.5 | 0 | | 6.25 | | |
| C16 - 273 | 2.50 | 7.5 | 0 | | 6.25 | | |
| C16 - 292 | 2.50 | 7.5 | 0 | | 6.31 | | |
| | | | | Avg. | 6.25 | .12 | ± .05 |
| C16 - 274 | 2.48 | 7.5 | -30 | | 8.88 | | |
| C16 - 275 | 2.50 | 7.5 | -30 | | 8.81 | | |
| C16 - 276 | 2.50 | 7.5 | -30 | | 9.44 | | |
| | | | | Avg. | 9.04 | .63 | ± .34 |
| C16 - 286 | 2.52 | 7.5 | -45 | | 13.12 | | |
| C16 - 287 | 2.50 | 7.5 | -45 | | 13.56 | | |
| C16 - 288 | 2.48 | 7.5 | -45 | | 12.00 | | |
| | | | | Avg. | 12.89 | 1.56 | ± .80 |
| C16 - 277 | 2.50 | 7.5 | -60 | | 16.25 | | |
| C16 - 278 | 2.52 | 7.5 | -60 | | 16.00 | | |
| C16 - 279 | 2.52 | 7.5 | -60 | | 15.88 | | |
| | | | | Avg. | 16.04 | .37 | ± .19 |
| C16 - 289 | 2.50 | 7.5 | -75 | | 17.06 | | |
| C16 - 290 | 2.50 | 7.5 | -75 | | 15.44 | | |
| C16 - 291 | 2.50 | 7.5 | -75 | | 16.12 | | |
| | | | | Avg. | 16.21 | 1.62 | ± .8[illegible] |
| C16 - 280 | 2.52 | 7.5 | -90 | | 13.25 | | |
| C16 - 281 | 2.50 | 7.5 | -90 | | 13.31 | | |
| C16 - 282 | 2.50 | 7.5 | -90 | | 16.00 | | |
| | | | | Avg. | 14.18 | 2.75 | ± 1.57 |
| C16 - 294 | 2.50 | 7.[illegible] | -105 | | 12.69 | | |
| C16 - 295 | 2.48 | 7.5 | -105 | | 13.38 | | |
| C16 - 296 | 2.50 | 7.5 | -105 | | 12.62 | | |
| | | | | Avg. | 12.89 | .76 | ± .41 |
| C16 - 283 | 2.50 | 7.5 | -120 | | 9.50 | | |
| C16 - 284 | 2.50 | 7.5 | -120 | | 8.94 | | |
| C16 - 285 | 2.50 | 7.5 | -120 | | 12.38 | | |
| | | | | Avg. | 10.27 | 3.44 | ± 1.84 |

Notes:
1. Cones assembled with DRC 15-10 bodies, plugs and rings.
2. Loaded at Ravenna Arsenal, BAT Lot No. 53 with Composition B from Holston Lot 4-1197.
3. All rounds were fired at Erie Ordnance Depot at the above indicated standoff and spin rates.

## Table VII
## Penetration Data
### *DRD78 HW2 Cones; 20-Degree Index Angle*

| Serial Number | Comp. B Wt. Lbs. | Standoff Inches | Rotation R.P.S. | Penetration Inches Mild Steel | Maximum Spread | Standard Deviation |
|---|---|---|---|---|---|---|
| C16 - 297 | 2.50 | 7.5 | 0 | 8.12 | | |
| C16 - 298 | 2.50 | 7.5 | 0 | 7.44 | | |
| C16 - 299 | 2.48 | 7.5 | 0 | 8.12 | | |
| | | | | Avg. 7.89 | .68 | ± .39 |
| C16 - 300 | 2.52 | 7.5 | 30 | 9.38 | | |
| C16 - 301 | 2.52 | 7.5 | 30 | 9.31 | | |
| C16 - 302 | 2.48 | 7.5 | 30 | 10.00 | | |
| | | | | Avg. 9.56 | .69 | ± .39 |
| C16 - 307 | 2.50 | 7.5 | 45 | 11.94 | | |
| C16 - 308 | 2.50 | 7.5 | 45 | 12.12 | | |
| C16 - 309 | 2.52 | 7.5 | 45 | 10.56 | | |
| | | | | Avg. 11.54 | 1.56 | ± .85 |
| C16 - 310 | 2.52 | 7.5 | 60 | 14.88 | | |
| C16 - 311 | 2.50 | 7.5 | 60 | 14.06 | | |
| C16 - 312 | 2.50 | 7.5 | 60 | 14.38 | | |
| | | | | Avg. 14.44 | .82 | ± .41 |
| C16 - 313 | 2.52 | 7.5 | 75 | 16.31 | | |
| C16 - 314 | 2.50 | 7.5 | 75 | 15.69 | | |
| C16 - 315 | 2.52 | 7.5 | 75 | 15.25 | | |
| | | | | Avg. 15.75 | 1.06 | ± .53 |
| C16 - 303 | 2.50 | 7.5 | 90 | 15.00 | | |
| C16 - 304 | 2.52 | 7.5 | 90 | 13.25 | | |
| C16 - 305 | 2.52 | 7.5 | 90 | 15.00 | | |
| | | | | Avg. 14.42 | 1.75 | ± 1.01 |
| C16 - 316 | 2.52 | 7.5 | 120 | 6.81 | | |
| C16 - 317 | 2.50 | 7.5 | 120 | 7.62 | | |
| C16 - 318 | 2.50 | 7.5 | 120 | 6.56 | | |
| | | | | Avg. 6.99 | 1.06 | ± .55 |
| C16 - 319 | 2.50 | 8.6 | 75 | 16.44 | | |
| C16 - 320 | 2.52 | 8.6 | 75 | 15.00 | | |
| C16 - 321 | 2.50 | 8.6 | 75 | 15.50 | | |
| C16 - 322 | 2.52 | 8.6 | 75 | 14.44 | | |
| | | | | Avg. 15.35 | 2.00 | ± 1.04 |

Notes:
1. Cones assembled with DRC 15-10 bodies, plugs and rings.
2. Loaded at Ravenna Arsenal, BAT Lot No. 53 with Composition B from Holston Lot 4-1197.
3. All rounds were fired at Erie Ordnance Depot at the above indicated standoffs and spin rates.

## Table VIII
## Penetration Data
### *DRB2-9 Controls For Modified DRD78-2 Cones*

| Serial No. | Comp. B (lbs) | Standoff (inches) | Rotation (rps) | Penetration (inches M.S) | Max. Spread (in.) | Std. Deviation (in.) |
|---|---|---|---|---|---|---|
| A-1191 | 2.48 | 7.5 | 0 | 20.69 | | |
| A-1192 | 2.50 | 7.5 | 0 | 19.00 | | |
| A-1193 | 2.52 | 7.5 | 0 | 20.12 | | |
| A-1194 | 2.52 | 7.5 | 0 | 18.88 | | |
| A-1195 | 2.52 | 7.5 | 0 | 21.38 | | |
| | | | | Avg. 20.01 | 2.50 | ± 1.52 |

Notes:
1. Cones assembled with DRC 15-10 bodies, plugs and rings.
2. Loaded at Ravenna Arsenal, BAT Lot No. 53 with Composition B from Holston Lot 4-1197.
3. All rounds were fired at Erie Ordnance Depot at 7.5 in standoff and 0 rps.

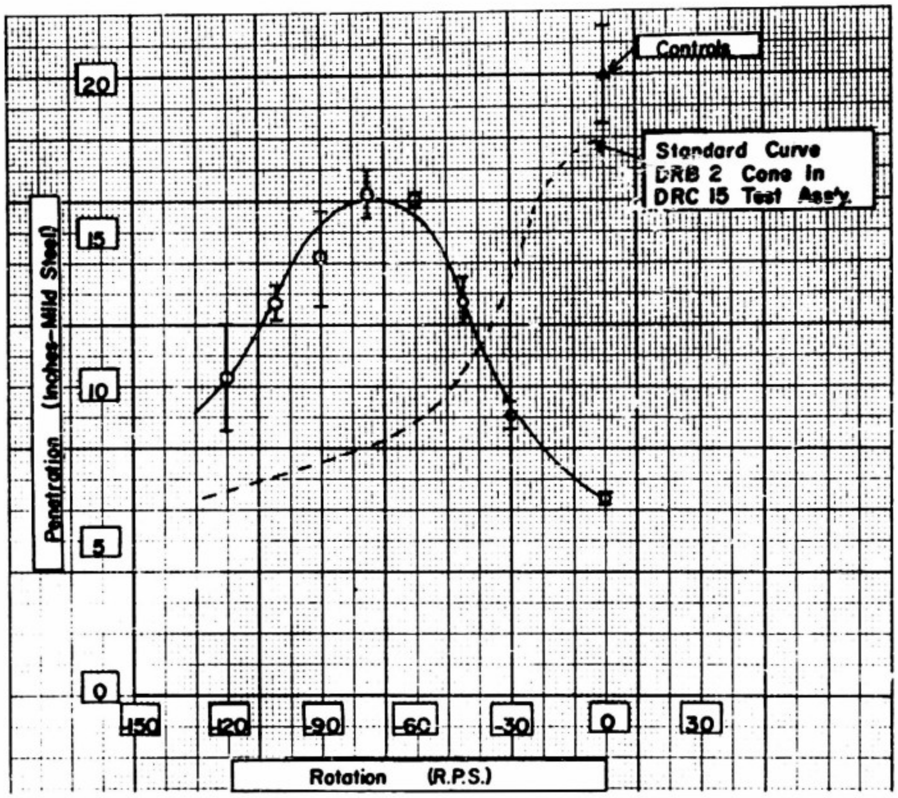



Fig. 6. Spin Rate Versus Penetration.
DRD78-2 HW1; 5-Degree Index.

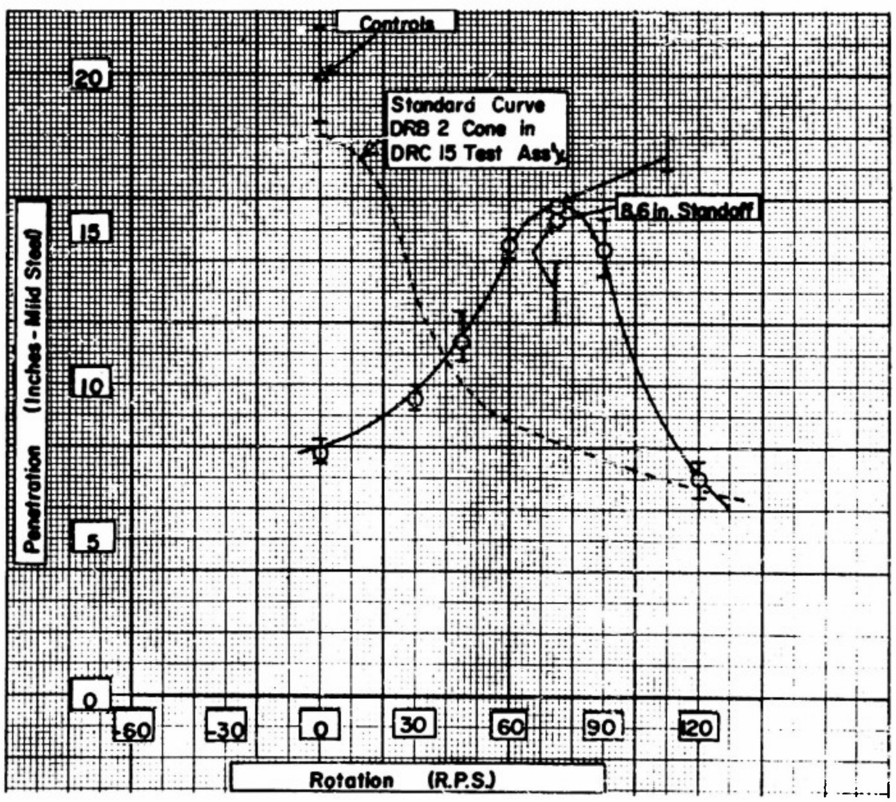



Fig. 7. Spin Rate Versus Penetration.
DRD78-2 HW2; 20-Degree Index.

## Effect Of Wall Thickness On Penetration

The usual average penetration for non-rotated DRB2 smooth controls at a stand-off of 7.5 in is 18.0 in of mild steel but in this test they penetrated an average depth of 20.01 in, an increase of 1.99 in. This increase is attributed to improved loading techniques and better Composition B explosive. Therefore, it can be assumed that the two series of indexed cones would experience a similar increase in penetration. Table IX summarizes the results of this test as observed and does not attempt to correct for this increase. The compensation observed in this experiment with the 5° index angle cones is 81.3% which compares well with the 82.2% observed in the earlier test. With the 20° index angles the efficiencies are 78.8% and 44.4% in the two tests. The tremendous improvement in the performance of the 20° index angle cones resulting from the increased wall thickness confirms that the low penetrations noted with the high index angles is truly the result of a thin wall section. These effects are shown graphically in Figs. 8 and 9.

**Table IX**
**Summary Of Test Results**

| EFFECT of INDEX ANGLE* | | | | | |
|---|---|---|---|---|---|
| Index Angle (deg.) | Flute Depth- inches Outside | Flute Depth- inches Inside | Min. Wall Thickness (inches) | $\gamma_o$ (rps) | $P_{\gamma_o}$ (inches M.S.) |
| 2.0 | .0281 | .0270 | .0964 | + 5 | 17.0 |
| 5.0 | .0269 | .0338 | .0938 | - 85 | 14.8 |
| 7.0 | .0276 | .0317 | .1068 | - 80 | 14.9 |
| 8.7 | .0278 | .0324 | .1044 | - 75 | 14.9 |
| 20.3 | .0277 | .0288 | .0766 | +100 | 8.0 |
| * Previously reported in the Supplement to the Thirty-Fourth Report | | | | | |
| EFFECT of WALL THICKNESS | | | | | |
| 5.0 | .0269 | .0338 | .0938 | - 85 | 14.8 |
| 5.0 | .0276 | .0272 | .1050 | - 75 | 16.21 |
| 20.3 | .0277 | .0288 | .0766 | +100 | 8.0 |
| 20.0 | .0275 | .0268 | .1042 | + 75 | 15.75 |

Relationship of Minimum Wall Thickness to $\gamma_o$ :

For 5° Index Angle

$$\frac{\gamma^{o}_{.0938}}{\gamma^{o}_{.1050}} = \left(\frac{t_{m(.1050)}}{t_{m(.0938)}}\right)^{x}$$

$x = 1.08 \pm 1.0$

For 20° Index Angle

$$\frac{\gamma^{o}_{.0766}}{\gamma^{o}_{.1042}} = \left(\frac{t_{m(.1042)}}{t_{m(.0766)}}\right)^{x}$$

$x = .935 \pm .3$

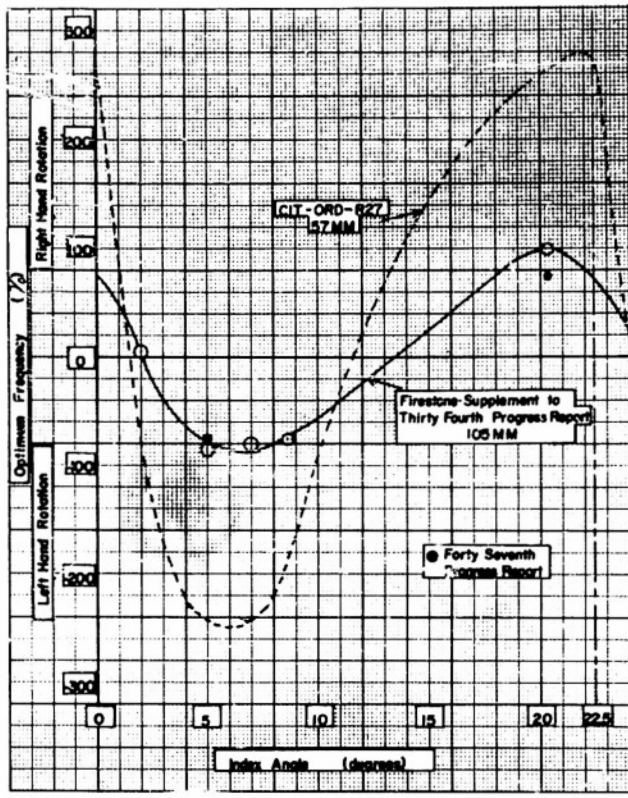



Fig. 8. Index Angle Versus Optimum Frequency.

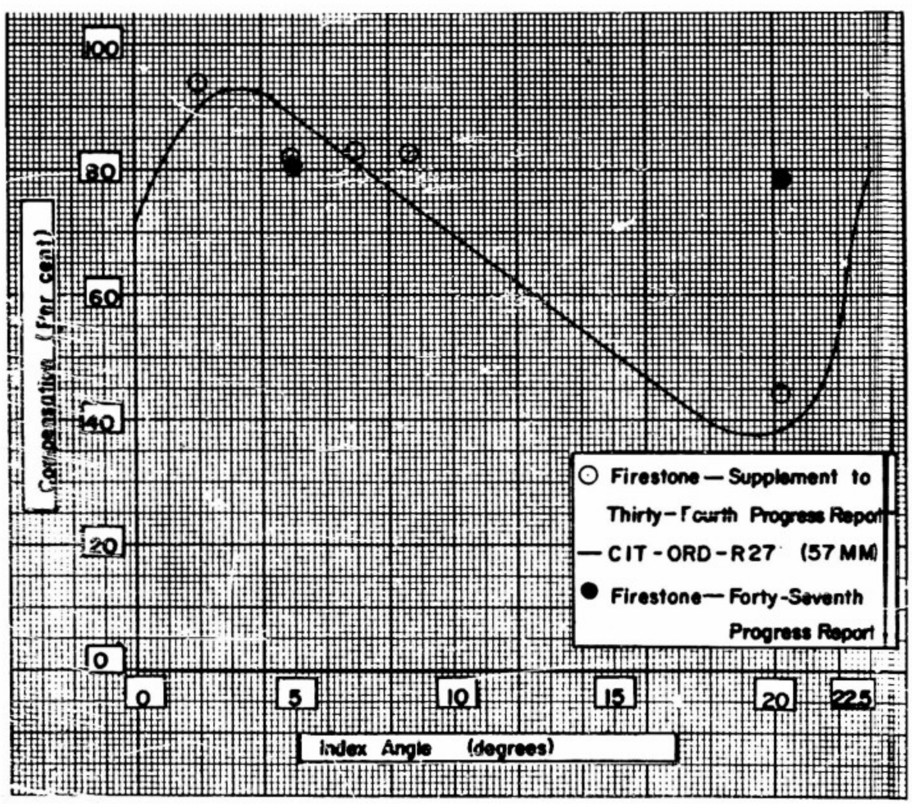



Fig. 9. Index Angle Versus Percent Compensation.

## Effect Of Wall Thickness On Optimum Frequency

Experience has shown that a change in the minimum wall thickness of fluted cones causes a change in the optimum frequency. Therefore, the observation that the optimum frequency, for both series of index angles used in this test, decreased with the increased minimum wall thickness, is expected. Carnegie Institute of Technology has conducted similar tests with liners of 1.63 in diameter. The results with the 1.63 in cones and the 3.4 in cones are strikingly similar. CIT reports that at an index angle of 5° to 6° the optimum frequency is approximately inversely proportional to the square of wall thickness, but that at an index angle of 20° the optimum frequency is approximately inversely proportional to the first power of the wall thickness. The change in wall thickness with Firestone cones with 5° index angle is too small to permit an accurate confirmation of the second power relationship, but the inverse linear relationship with the 20° index angle cones is confirmed. The Carnegie Institute data are presented in CIT Status Report Number 1, page 64 through 81, dated January 31, 1954 and CIT Status Report Number 2, page 45 through 79, dated April 30, 1954.

## Future Program

1. Serrated Liners

a. DRD433 item 2 and item 3 cones (Index angle 6° and 2°, respectively) are being manufactured. These cones have 50 "matching" flutes .034 in. deep at the base datum and a wall thickness of .100 in.

b. DRD429 item 2. These cones have 16 "matching" flutes, .034 in. deep at the base datum and a wall thickness of .100 in. Index angle is 6°. Flute orientation is the reverse of DRD78.

c. DRD434 item 2. Same as (b) except flute depth is .060 in.

Above three groups of cones are being inspected.

d. Scaling Studies

DRD267 (3.5 in. base x .100 in. wall); DRB704 (3.0 in. base x .087 in. wall); DRB703 (2.5 in. base x .071 in. wall). These cones have 60 flutes machined in the outside to a depth of .010 in., .0085 in., and .0069 in. respectively at the base datum.

All cones have been manufactured and inspection has been initiated.

e. Threaded Cones

DRB998, threaded inside, 60°V threads 28/in., .0097 in. deep, .0357 in. pitch.

DRB999, triple threaded inside, 60°V threads, 84/in., .0097 in. deep, .0119 in. pitch, .0357 in. lead.

DRB1000, threaded outside, 60°V threads, 28/in., .0375 in. pitch, .0097 in. deep.

DRB1001, triple threaded outside, 60°V threads, 84/in. .0357 in. lead, .0119 in. pitch, .0097 in. deep.

The above cones are being tested.

f. Flute Run Cut Study

DRD23-509 item 1, 2 and 3 cones have been manufactured. The three series have 60 external flutes with a flute depth of .0127 in. at the base datum. The flutes run out at positions 2.315 in., 1.710 in., and 1.105 in. above the base respectively for these cones.

g. Effect of Flute Depth

DRD23-508 item 1, 2 and 3 cones have been manufactured. The three series have 60 external flutes with flute depths of .0127 in., .0192 in., and .0070 in., respectively at the base datum.

h. Dynamic Firing of Compensating Liner

DRD393-1 item 2 and DRB398-9 cones have been incorporated in T138E74 and T138E75 projectiles and shipped to Picatinny Arsenal for loading. These rounds will be used in a dynamic and static firing test to be scheduled at Aberdeen Proving Ground. An additional group of DRB398-9 cones in T138E74 projectiles are being loaded at Ravenna Arsenal for static tests at Erie Ordnance Depot.

2. Double Body Projectile Study

a. Six projectiles are to be fired to complete the study on the determination of minimum wall thickness required in non-rotated body. The projectiles have wall thicknesses as follows:

(1) 2 rounds with .180 in. wall (alum) in rear body.

(2) 2 rounds with .120 in. wall (alum) in rear body.

(3) 2 rounds with .060 in. wall (alum) in rear body.

Assemblies are being inert loaded at Ravenna Arsenal.

b. Determination of Strength of Tee or Boom.

Tees of five different designs and strength, using both aluminum and steel, are to be tested. Manufacture is completed and tests are scheduled.

## Nose Element Sensitivity

A series of tests, investigating the sensitivity of potted lucky nose elements were described in the Forty-Sixth Progress Report. It was reported that "potted lucky" nose elements with steel walls .020 in thick functioned on Kraft paper (.0045 in). This was thought to be too sensitive and a future program was outlined to (1) determine if the functioning was caused by mechanical shock, transmitted to the "lucky" through the body of the projectile, and (2) test caps with heavier walls.

### *Protective Caps*

Five rounds with potted lucky units were equipped with protective caps as shown in Fig. 10 and fired for graze impact at ranges of 150 ft to 1000 ft. The first round was aimed slightly high and after passing through high grass and weeds for a considerable distance struck the ground and exploded at approximately 200 ft. The four other rounds impacted at ranges of 150 ft to 1000 ft. One of these rounds functioned high order in the air at 250 ft, after skipping off the ground, the remaining three functioned in the woods some 2500 ft from the gun. It is a possibility that the protective nose cap became loose after impact, on the round that functioned in the air.

Five rounds equipped with the same protective nose cap, Fig. 10, and a control round without the protective nose cap were fired through 1/8 - inch chip board. None of the rounds with the protective cap functioned on the chip board but all functioned in the woods down range. The round with the protective cap removed and with .020 in steel wall cap functioned on the chip board.

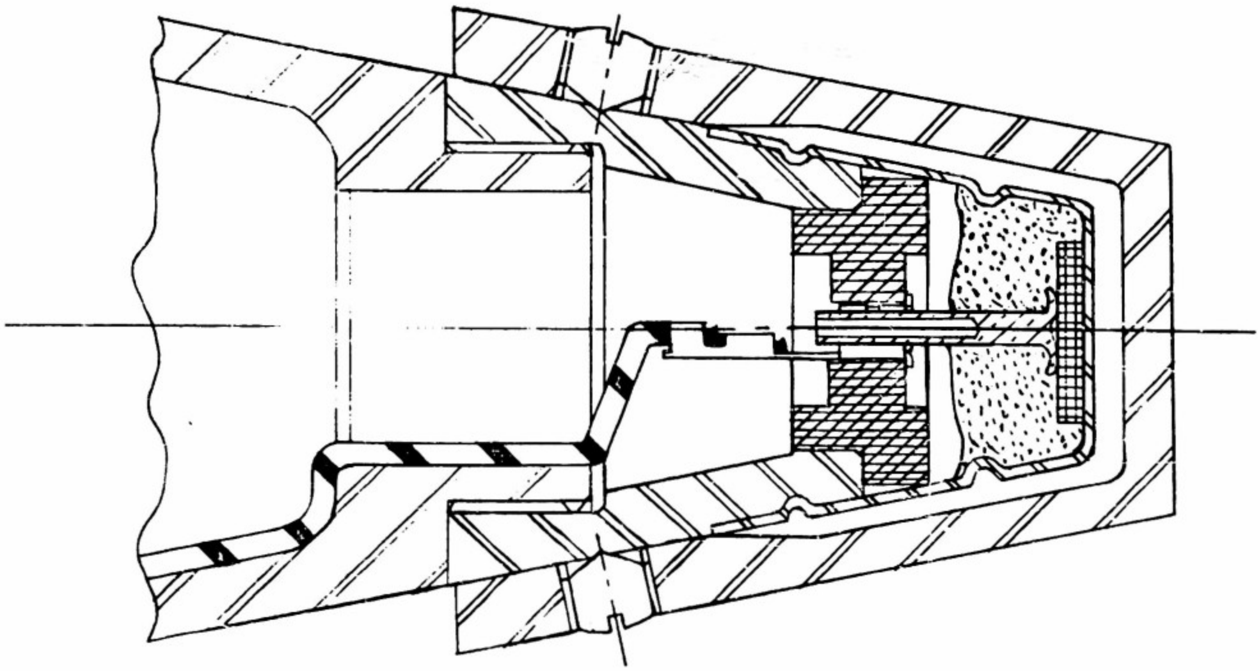


Fig. 10. Protective Nose Cap.

### Nose Cap Wall Thickness

In the test of potted lucky caps made of heavier material than the standard .020 in, three rounds were fired, with the potted lucky cap made of .060 in steel, at vertical targets.

The first round functioned on .5-inch pine board, the second functioned on chip board and the third on .0045-inch Kraft paper. This cap thus proved to be as sensitive to function as the cap with .020-inch wall.

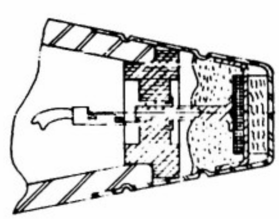
Having established the performance against vertical targets, five rounds with lucky nose caps with .060-inch walls were fired for graze at 150 ft to 1000 ft. All rounds functioned high order with no evidence of contact of the body or fins with the earth. Swaths left by the projectile were visible through the knee-high grass for a distance between the gun and the point of functioning. It appears that functioning was caused by impact of the nose caps on the blades of grass.

These tests indicate that the lucky element is functioned by a shock wave transmitted through the metal cap. The future program outlines a series of tests to attempt to lower the sensitivity of the system.

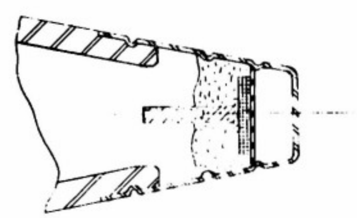
### Future Program

**"PROGRAM FOR EVALUATION OF POTTED LUCKYS"**
**MATERIALS FOR TESTING**

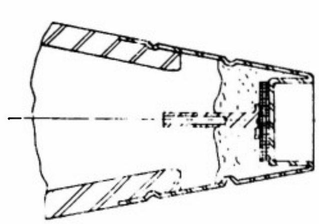
| | | | |
|---|---|---|---|
| Group 1 | 10 | Potted Luckys with 1/64" | Paper baffle. |
| Group 2 | 10 | Potted Luckys with 1/32" | Paper baffle. |
| Group 3 | 10 | Potted Luckys with 1/16" | Paper baffle. |
| Group 4 | 10 | Potted Luckys with 1/8" | Paper baffle. |
| Group 5 | 10 | Potted Luckys with 1/4" | Paper baffle. |
| Group 6 | 10 | Potted Luckys with 1/4" | Air Gap. |
| Group 7 | 10 | Potted Luckys with 1/4" | Overhang. |
| Group 8 | 10 | Potted Luckys with 1/2" | Crystal in 5/8 cap. |



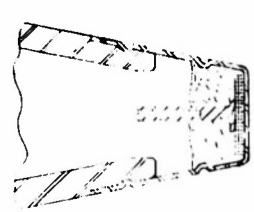
Group 1, 2, 3, 4, 5



Group 6



Group 7



Group 8

## PROPOSED PROGRAM

1. Fire 2 pcs group 5 against 1" pine.
1a* If item 1 functions fire 2 pcs group 5 against 1/2" pine.
1b* If item 1a functions fire 2 pcs group 5 against chip board.
1c* If item 1b functions fire 2 pcs group 5 against Kraft paper.
2. If item 1 fails to function fire 2 pcs group 3 against 1" pine.
2a* If item 2 functions fire 2 pcs group 3 against 1/2" pine.
2b* If item 2a functions fire 2 pcs group 3 against chip board.
2c* If item 2b functions fire 2 pcs group 3 against Kraft paper.
3. If item 2 fails to function fire 2 pcs group 1 against 1" pine.
3a* If item 3 functions fire 2 pcs group 1 against 1/2" pine.
3b* If item 3a functions fire 2 pcs group 1 against chip board.
3c* If item 3b functions fire 2 pcs group 1 against Kraft paper.
4. If a differentiation occurs in any group above choose either group 2 or 4 and repeat steps shown in tests 1, 2 and 3. This step to be taken dependent upon the point of differentiation in thickness.
5. Fire 2 pcs group 6 against 1" pine.
5a* If item 5 functions fire 2 pcs group 6 against 1/2" pine.
5b* If item 5a functions fire 2 pcs group 6 against chip board.
5c* If item 5b functions fire 2 pcs group 6 against Kraft paper.
6. Fire 2 pcs group 7 against 1" pine.
6a* If item 6 functions fire 2 pcs group 7 against 1/2" pine.
6b* If item 6a functions fire 2 pcs group 7 against chip board.
6c* If item 6b functions fire 2 pcs group 7 against Kraft paper.
7. Fire 2 pcs group 8 against 1" pine.
7a* If item 7 functions fire 2 pcs group 8 against 1/2" pine.
7b* If item 7a functions fire 2 pcs group 8 against chip board.
7c* If item 7b functions fire 2 pcs group 8 against Kraft paper.

NOTE: * Sub-items, a, b, and c are to be fired only when functioning occurs on 1" pine.

## MANUFACTURING SUMMARY

In addition to the experimental material prepared for the research and development work under contract DA-33-019-ORD-1202, described in preceding progress reports and in the preceding pages of this report, the following have been manufactured and shipped to the installations indicated. Firestone's Defense Research Division, in shipping these items, transfers custody and control of the items to the receiving agencies. However, personnel of Defense Research Division will continue to collaborate with personnel of the other installations.

I. Cartridges, HEAT, 106mm, M344 (T119E11) Without Fuzes T208E7

| | | | |
|---|---|---|---|
| Prior to | June 1, 1954 | 16,715 | All Shipments |
| | No Shipments in June | | |

II. Rifles, T170E1 for ONTOS

| | | | |
|---|---|---|---|
| Prior to | June 1, 1954 | 129 | All Shipments |
| | June 12, 1954 | 5 | Aberdeen Proving Ground |
| | Total | 134 | |

III. Mounts, T173 and T26 Tripod for ONTOS

| | | | |
|---|---|---|---|
| Prior to | June 1, 1954 | 26 | All Shipments |
| | June 24, 1954 | 8 | Fort Bragg |
| | Total | 34 | |

IV. BAT Systems less Jeep, T170E1 (M40) Rifle, T149E3 (M79) Mounts (with latest modifications).

| | | | |
|---|---|---|---|
| Prior to | June 1, 1954 | 25 | All Shipments |
| | No Shipments in June | | |

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